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14. ABSTRACT Advances in medical knowledge and technology have created new opportunities for disease specific diagnosis and treatment. The increase in and complexity of medical data at various levels of resolution has increased the need for system level advancements in clinical decision support systems that provide computer-aided analysis for diagnostics and treatment. In order to facilitate a more rapid and systematic transfer of new medical knowledge and capabilities into mainstream clinical practice, a new Medical Information Network Decision Support (MINDS) system is proposed. This system is intended to be a platform for storing and fusing medical data across all levels (e.g. from low-level genomic and proteomic data to higher level clinical data) in a standardized way, and provide probabilistic diagnostic and treatment decisions to assist doctors and medical researchers in understanding and treating disease. This tools is viewed as complementary to the many other information technologies that are streamlining the health care administration processes and empowering patients through web-based informational tools. The pilot application will be targeted to breast cancer diagnosis and treatment, and later expanded to other diseases. The system will build upon the information fusion and decision architecture technology that is currently being developed in the Missile Defense community and apply it to the medical science of identification, tracking, and treatment of disease. It will provide initial diagnostic and treatment models for breast cancer, and refine those models using validated, state-of-the-art research techniques applied to clinical data, medical imaging data, experimental proteomics data, and cell-based experimental data. The ultimate goal is to provide a rapid and systematic introduction of the latest medical knowledge and techniques into mainstream medical practice throughout the medical community and within large national systems.					
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Introduction

Advances in medical knowledge and technology have created new opportunities for disease specific diagnosis and treatment. The increase in and complexity of medical data at various levels of resolution has increased the need for system level advancements in clinical decision support systems that provide computer-aided analysis for diagnostics and treatment. In order to facilitate a more rapid and systematic transfer of new medical knowledge and capabilities into mainstream clinical practice, a new Medical Information Network Decision Support (MINDS) system was proposed. This system is intended to be a platform for storing and fusing medical data across all levels (e.g. from low-level genomic and proteomic data to higher level clinical data) in a standardized way, and provide probabilistic diagnostic and treatment decisions to assist doctors and medical researchers in understanding and treating disease. This tool is viewed as complementary to the many other information technologies that are streamlining the health care administration processes and empowering patients through web-based informational tools. The pilot application will be targeted to breast cancer diagnosis and treatment, and later expanded to other diseases. The system will build upon the information fusion and decision architecture technology that is currently being developed in the Missile Defense community and apply it to the medical science of identification, tracking, and treatment of disease. It will provide initial diagnostic and treatment models for breast cancer, and refine those models using validated, state-of-the-art research techniques applied to clinical data, medical imaging data, experimental proteomics data, and cell-based experimental data. The ultimate goal is to provide a rapid and systematic introduction of the latest medical knowledge and techniques into mainstream medical practice throughout the medical community and within large national systems.

Body

Project Summary and Revisions

The MINDS project was envisioned to begin as a three-year congressionally funded research project that was based on three phases of funding to be provided between the 2006 and 2008 federal fiscal years. The total anticipated funding for all three phases was \$10 million. Due to several factors affecting the federal budget process the total congressional funding provided to date is \$2 million, out of which approximately \$850K has been awarded to TechFinity. Another \$850K, approximately, is awaiting approval of the continuation request that will be submitted later this year.

Due to the limitation in the funding, it has been difficult to secure the resources of a medical research partner, as well as hire the additional TechFinity staff required to support the project goals that were originally laid out in the proposal. As a result it has been necessary to scale back the scope of the original project in order to target the available resources to a more focused research program. The primary modifications will encompass the following:

- Limiting the scope of the medical data types that will be considered in the development of the initial prototype decision support models for breast cancer diagnostics and treatment (specifically image data, including X-ray, Ultrasound, MRI, medical/family history related to breast cancer, pathology data, limited set of clinical data that is generally considered to be more accurate for risk prediction). A starting sample size of less than 500 patients will be utilized to begin the initial model development. It is anticipated that baseline diagnostic and treatment models will be developed such that the initial prototype can provide diagnostic and treatment recommendations to a doctor that are consistent with what a typical patient would receive at a hospital or clinic. It is important to establish such a baseline model and computer-generated output for the credibility of the computer model and as a benchmark for future model improvements that will incorporate more advanced technologies and additional sources of data (e.g. genomic, proteomic data) that become available. A key research objective in the development of the models will be to determine how a suitable probabilistic measure can be attached to the various types of inputs that are provided to the fusion engine.
- Emphasizing the development of the MINDS system architecture and software framework with the goal of enhancing the interoperability of existing research technologies that are currently in use or under development at breast cancer research centers. This would entail identifying research labs or centers that have specific advanced technologies that provide key information relevant to breast cancer diagnostics or treatment, and working with them to integrate their various toolsets or other capabilities within an integrated decision support framework.
- Initiating small-budget, limited-hour consulting contracts to medical research consultants for the purpose of helping to enhance the more targeted use of the available funding and to better identify suitable medical research partners.

The current MINDS contract detailed four tasks in the statement of work. A summary of each task and progress made to date is described below.

Task 1: MINDS System Enhancements to Clinical Decision Support Initiatives

The general purpose of this task is to provide a comprehensive summary background on the current status of health information technology (HIT) and clinical decision support (CDS) tools and initiatives that would be relevant to some aspect of the MINDS system concept. The goal of this survey is to provide a clear description of what current technologies and initiatives exists in these areas, and highlight the advanced contributions that MINDS system would make in the broader HIT and CDS arena.

A key part of this survey is the identification of existing standards and protocols that are currently utilized by the medical industry. These standards will be evaluated for their usefulness

in the current MINDS project as first step in making the MINDS system compatible with the existing medical network infrastructure so that it will more easily interface with existing equipment, tools and information networks.

Another key part of the survey is an evaluation of prior and existing clinical decision support systems that have been utilized in breast cancer research and clinical practice. An analysis will be done to determine which of the existing techniques are useful within the proposed MINDS system architecture.

Finally, the survey will identify key areas of improvement that will be pursued in future funding cycles in order to develop improved decision support algorithms, data formats and modernized data structures, and general system architecture.

The survey begins by examining the need for innovation in the area of clinical decision support. While the perceived benefits of these types of systems have been suggested for decades, there still remains a conspicuous lack of implementation of such systems, and there don't appear to be any series efforts in the development of systems that integrate existing capabilities into a larger decision support system (see Figure 1).

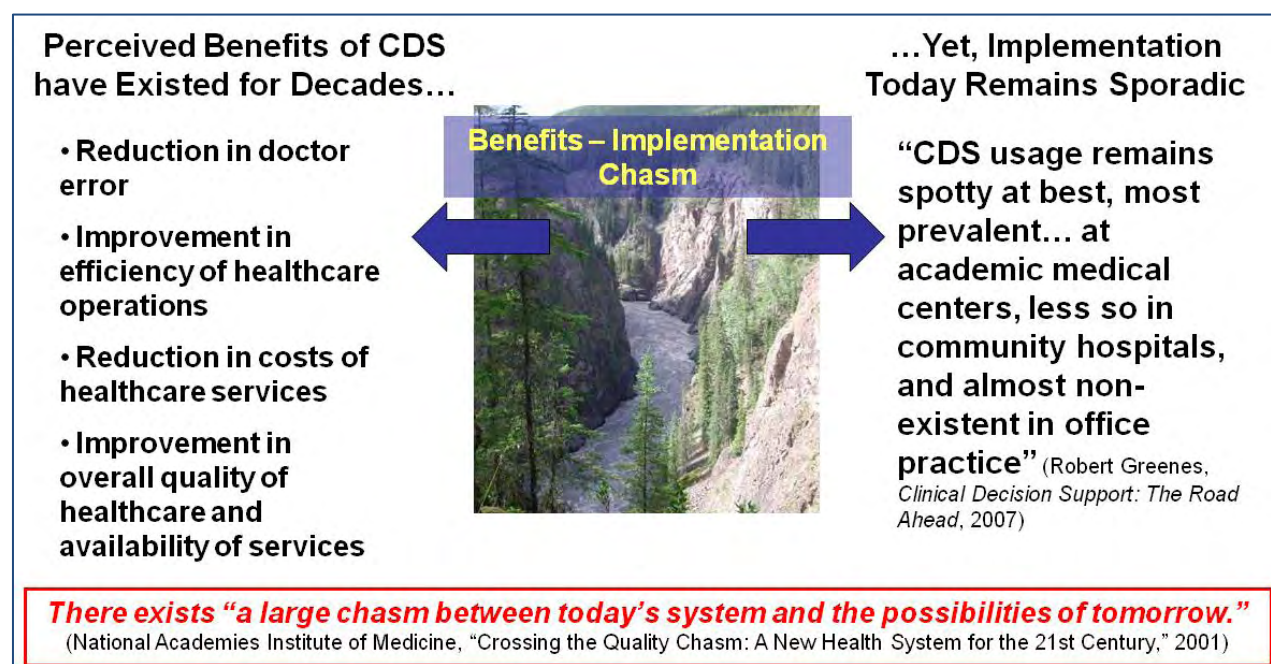


Figure 1: Benefits – Implementation Chasm for Clinical Decision Support

The survey provides an overview of the key domain areas of clinical information systems (CIS) in general. We have identified six core areas where clinical information systems have provided some level of computerized or automated support to the medical community (see Figure 2). Each of these core areas is further regulated by an underlying set of quality control rules, ethical

practices, and government regulation. The key contributions that we anticipate the MINDS system providing to the broader CIS are in the medical / clinical decision support area, and in the research and training support systems.

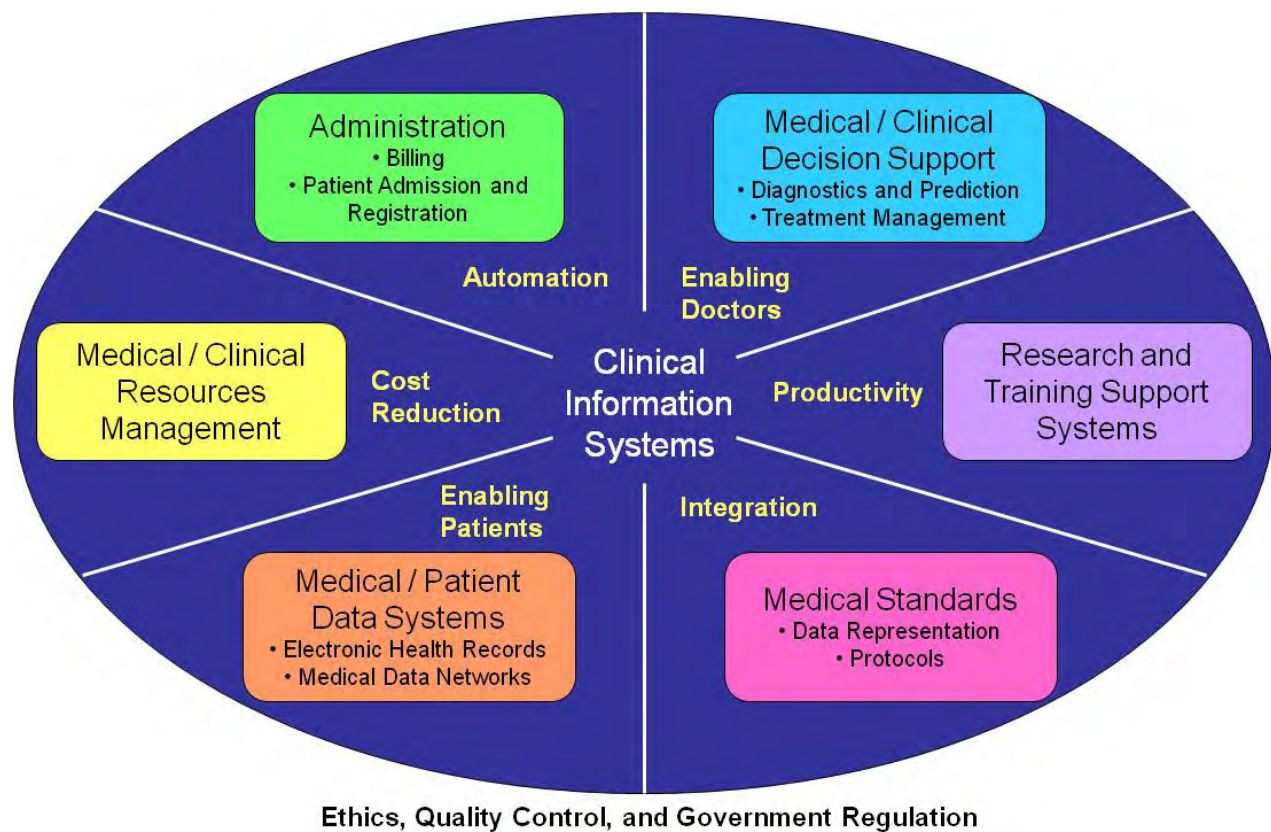


Figure 2: Six Domains of Clinical Information Systems

In the Medical/Patient Data Systems area, there are three core subareas that are currently receiving the most attention in terms of health information technology development. These include development efforts in electronic health records (EHR), in regional health networks, and in online services. The core focus of national HIT efforts have been in developing standardized digital EHR for use by different hospitals, clinics and other medical institutions. Initially there was also interest at the national level in developing a nation-wide health information network that would serve as a network backbone for various medical institutions, but those efforts at the national level have currently been put on hold. The current efforts in developing medical information networks are occurring primarily at the regional level, where hospitals and their affiliated outpatient clinics and other service centers are all linked by a common network and can share information that has been put in standardized medical record formats. A third key area that has been emerging in the last couple of years is online medical services that are primarily patient driven. These websites provide libraries of medical information and also allow patients to

upload medical information that can then be shared with medical service providers. The major software companies have been leading the way in this area including:

- Revolution Health (started by Steve Case, founder of AOL)
- Microsoft HealthVault
- Google Health (coming online soon)

The survey will examine the features that these websites will provide to users, as well as look at some of the anticipated capabilities that these sites may try to provide.

The Medical Standards area includes several classifications of standards that are relevant to different aspects of the decision support process. These areas include:

- Terminology / Data Standards – these include standardized codes for medical or laboratory data, standardized classification schemes, and other data formats (examples include ICD-10, SNOWMED, etc.)
- Medical Concept Standards – these include standardized methodologies for representing medical concepts (examples include HL7-RIM and UMLS)
- Medical Document Standards – these include standards for preparation of medical documents in general (examples include HL7-CDA and CCR)
- Messaging and Protocol Standards – these include standards for electronic communication of medical information (examples include HL7 v2 and v3, DICOM, NCOD, and several IEEE standards)
- Medical Application Standards – these include standards for the design of medical application architectures (examples include HL7-CCOW)

The Medical/Clinical Decision Support area consists of several subsections including:

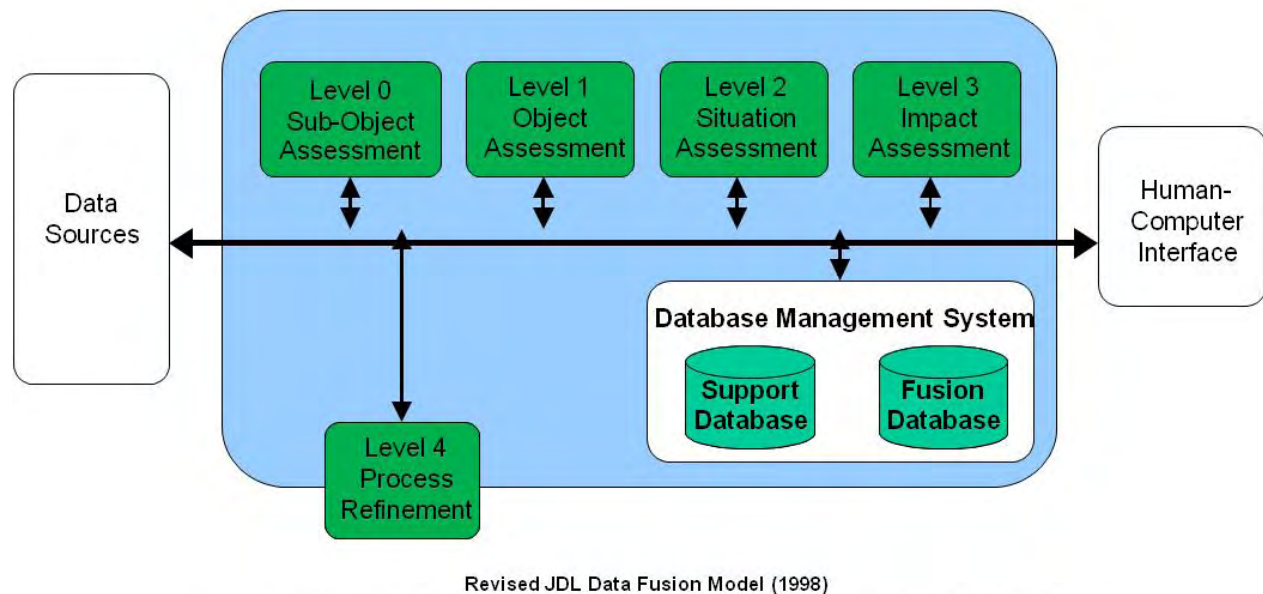
- Computer-based Physician Order Entry (CPOE)
- Electronic Prescribing
- Diagnosis and Disease Propagation
- Optimized Treatment Strategies and Planning
- Preventative Care (Planning and Scheduling)

The CPOE and electronic prescribing tools have been developed successfully and are not of primary interest in the MINDS system. However, the automation of data analysis to provide doctors with support of diagnosis and disease propagation, treatment planning for desired outcomes, and preventative care are key interest areas in the MINDS system. Additional

research is being performed on some of the existing techniques that have been applied to the breast cancer problem.

Task 2: MINDS Architecture Design

The goal of this task is to develop a preliminary design of the system level architecture needed to support MINDS. The general decision architecture is modeled after the JDL Fusion model, which has been adapted to fit the appropriate medical terminology (see Figure 3). The JDL model helps to associate a data level with the processes involved in analyzing that data. These data analysis processes can also be mapped to medical processes that can be supported by a data analysis process. In Figure 4 the medical processes that are mapped to fusion and resource management processes are described.



Based on Hall, D. L. and Llinas, J., *Handbook of Multisensor Data Fusion*, CRC Press, 2001.

Figure 3: Modified JDL Fusion Model for Medical Decision Support

<u>JDL Level</u>	<u>Data Entity</u>	<u>Estimation Process</u>	<u>Medical Analogy</u>
0 (Sub-object Assessment)	Signal / Pixel	Detection	Screening
1 (Object Assessment)	Physical Object	Fusion of Data Attributes and Characteristics	Integrated Patient Information
2 (Situation Assessment)	Object Aggregates	Malignancy Characterization	Diagnosis
3 (Impact Assessment)	Object Aggregates	Interactions / Options Analysis	Intervention / Treatment Options
4 (Process Refinement, Resource Management)	Action or Improvement Plans	Option Selection, Optimization, Execution	Resource / Treatment Plans and Allocations

Figure 4: Mappings of JDL Fusion Levels and Medical Processes

As the decision support models are developed and refined, the specific structures of the decision support modules within the software framework will be developed.

The general software framework upon which the decision support architecture is built is a modular system that provides the ability to interface MINDS with other systems and tools. The functional hierarchy shown in Figure 5 shows the modular structure of the main components needed to build a basic system. Each module may consist of several individual packages that can be included to form a particular application. Modules are reused among applications that have similar functions. The modules of the system are utilized within an application flow diagram (see Figure 6) that can be utilized in fusing data sources and generating appropriate data models. The system architecture will support an initial prototype of both a research tool (used to support development models) and a support tool (used to provide decision support summaries to doctors).

The modularity of the system is further enhanced by the definition of different software layers (see Figure 7) that allow higher level processing to be isolated from the lower level messaging and network interface protocols. This has the advantage of allowing the system to be more easily connected to other systems that may utilize different communications or messaging protocols without having to modify the basic data processing elements. This will improve the overall maintainability of the system.

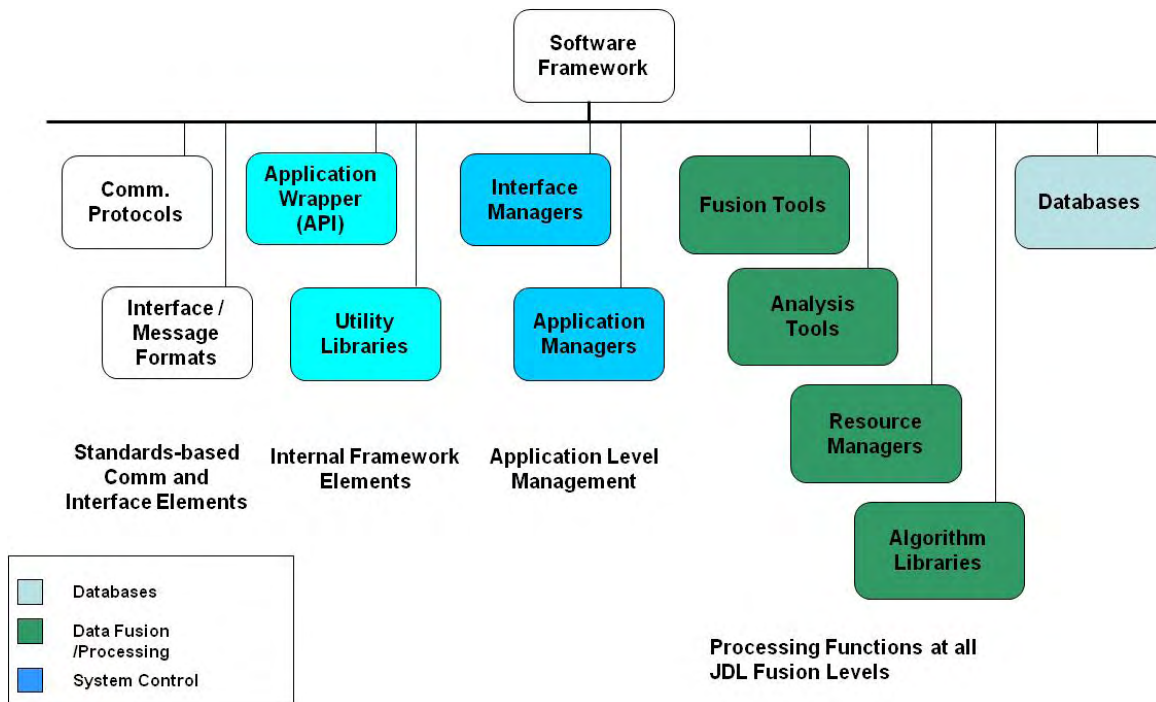


Figure 5: MINDS Functional Hierarchy

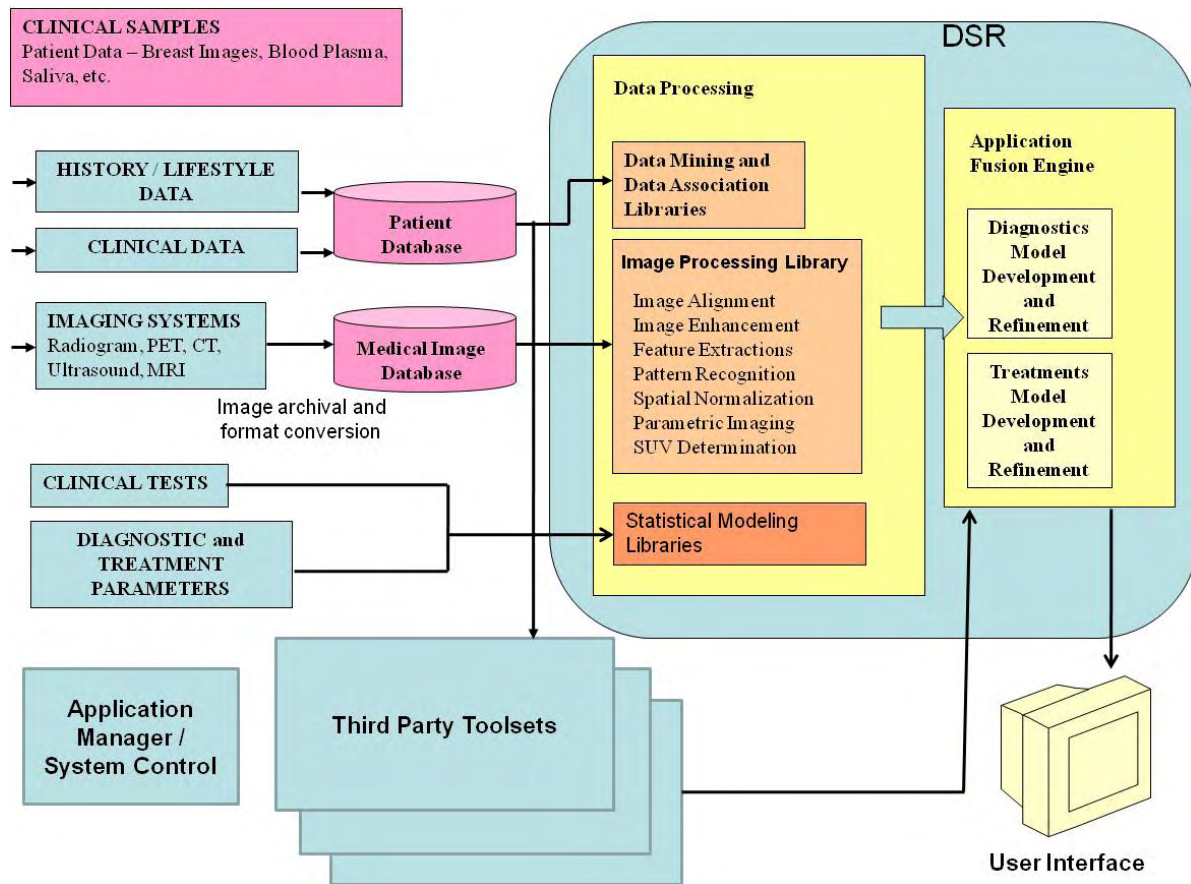


Figure 6: Sample System Flow Diagram for MINDS System for Model Development

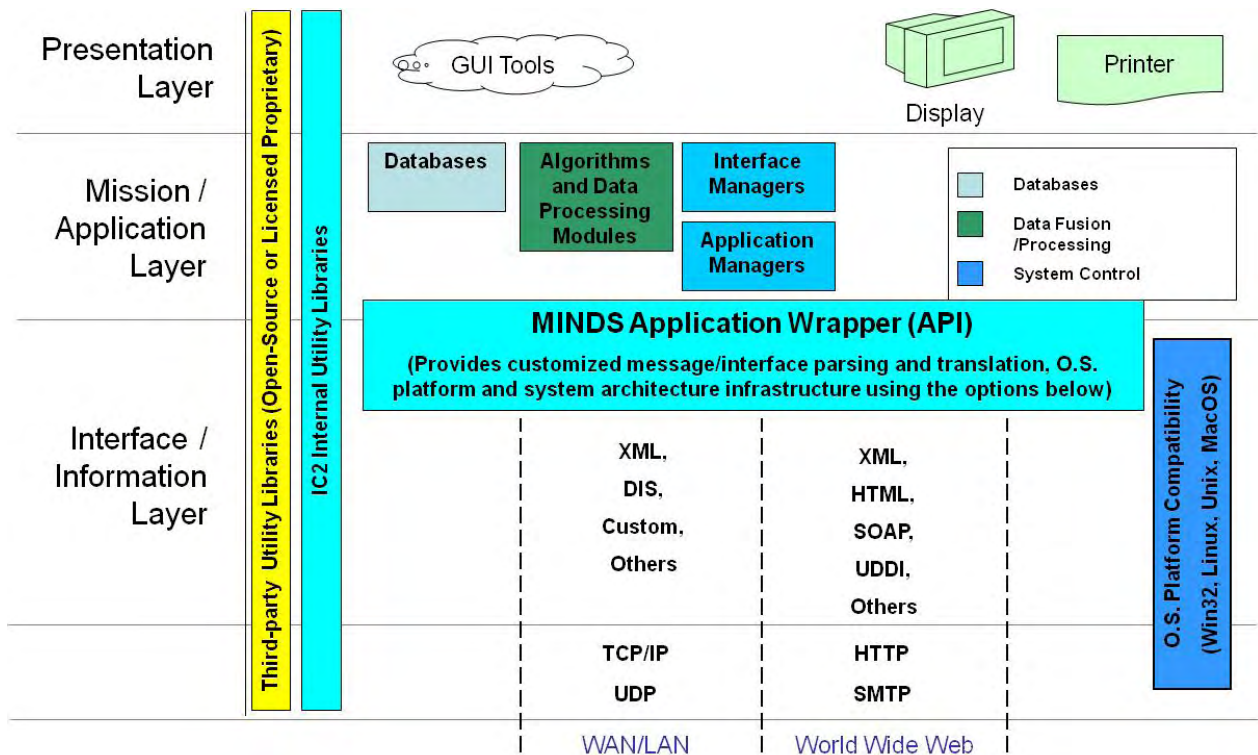


Figure 7: MINDS Software Layers

Task 3: Initial Diagnostic and Treatment Models for Breast Cancer

The goal of this task is to create a modernized data structure for handling patient data of different types that will be utilized by the decision support models. Once the data structures are created and some initial data sets gathered, preliminary models will be developed for diagnostics and treatment of breast cancer. These preliminary models will provide a baseline for evaluation of future model improvements. The baseline models are expected to be limited in scope and complexity, and be representative of the current level of care that may be provided at a typically cancer diagnosis and treatment facility.

Initial efforts to start this portion of the project have been hampered by challenges in establishing subcontract agreements with a suitable subcontractor with medical domain expertise and data. The initial plan was to work with the group of researchers at UCLA department of radiation/oncology. This effort evolved and was eventually modified to be a joint effort in proteomics analysis by the RAD/ONC and surgery departments. Unfortunately, a suitable agreement on the required level of funding to support UCLA staff and students was not achieved.

A subsequent effort to work with Walter Reed Army Medical Center and Winbur Research Institute is ongoing, although there are some challenges here with the workloads that the WRAMC and WRI staff currently supports.

TechFinity is also in discussions with other UCLA medical school staff in the departments of epidemiology, and researchers at the breast cancer centers at Johns Hopkins University. It is hopeful that a suitable working relationship can be formed to begin making progress on this task. In addition to these potential opportunities, TechFinity will also be hiring consultants to help refine the actual tasks and support the initiation of the subcontracts.

Task 4: Initial Planning and Experimentation to Enhance Breast Cancer Modeling

The final task of this contract is to develop a future plan and roadmap for research and experimentation to improve upon the initial baseline models for breast cancer diagnosis and treatment. The initial task as outlined in the statement of work was fairly specific to the anticipated working relationship with UCLA RAD/ONC. As this is currently not a viable option, this task will be revised once a subcontract has been issued to a suitable medical partner.

Key Research Accomplishments

- Clinical Information Systems and Health Information Technology survey
- Preliminary architecture for the MINDS system

Reportable Outcomes

The final preparation of the CIS / HIT survey is underway and will be completed before the end of the next quarter.

Conclusion

The accomplishments of the first phase of the MINDS project during the first year have been fairly successful. Significant progress was made on the first two tasks and the report on the survey will be delivered during the next quarter. The preliminary MINDS architecture design is on track to be completed by the end of the calendar year. There have been some setbacks in establishing the working relationship with a medical research partner, but several potential routes of collaboration are currently in negotiations, and the additional continuation funding will support will provide the additional funds to help enhance the subcontract funding. The current funding schedule and progress is summarized in Figure 8.

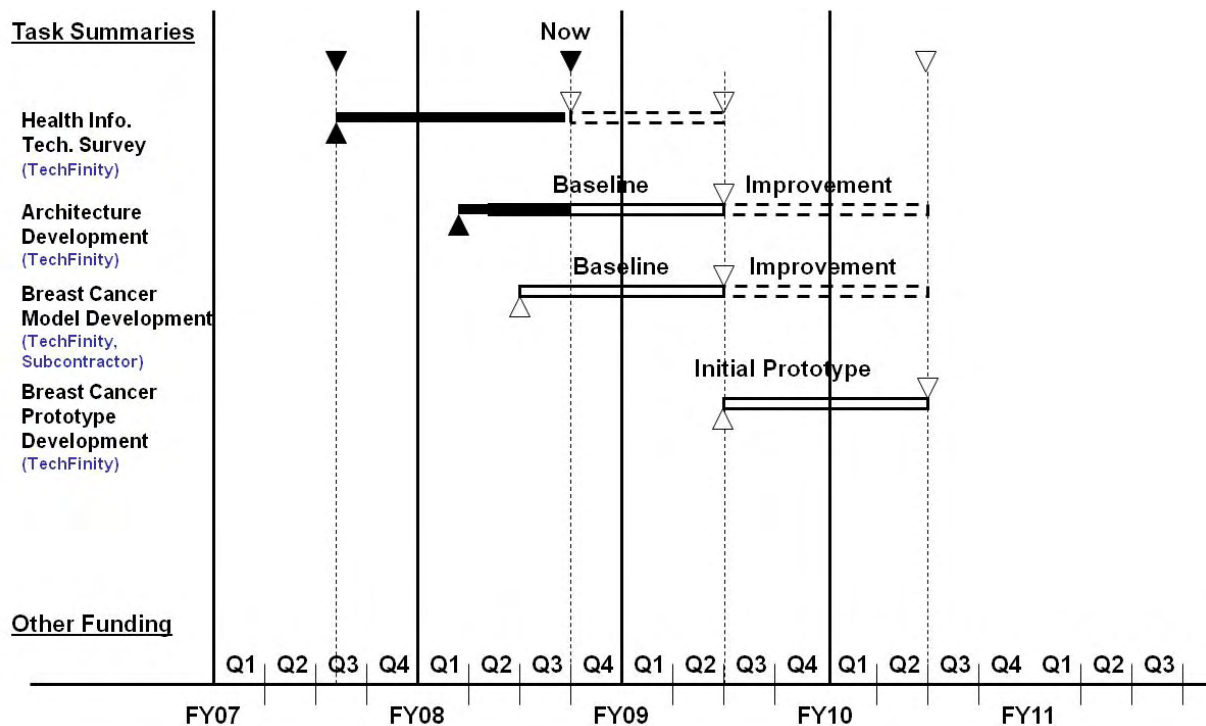


Figure 8: Current Funding Schedule and Progress

References

1. Berner, Eta S. (Ed.), *Clinical Decision Support Systems: Theory and Practice*, Springer, 2007
2. Chen, Hsinchun, et. al. (Eds.), *Medical Informatics: Knowledge Management and Data Mining in Biomedicine*, Springer, 2005
3. Greenes, Robert A. (Ed.), *Clinical Decision Support: The Road Ahead*, Elsevier Inc., 2007
4. Jordan, Theresa J., *Understanding Medical Information: User's Guide to Informatics and Decision Making*, McGraw-Hill, 2002
5. Osheroff, J.A., et. Al., "A Roadmap for National Action on Clinical Decision Support," AMIA, 2006
6. Teich, Jonathan M., Osheroff, Jerome A., "Clinical Decision Support in Electronic Prescribing: Recommendations and Action Plan," Commissioned by the Office of the National Coordinator for Health Information Technology, Department of Health and Human Services, 2005
7. The Lewin Group, Inc., "Health Information Technology Leadership Panel: Final Report," 2005
8. Shortliffe, Edward H., et. al. (Eds.), *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, Springer, 2006
9. Taylor, Paul, *From Patient Data to Medical Knowledge: Principles and Practice of Health Informatics*, Blackwell Publishing, 2006

10. Van de Velde, Rudi, Degoulet, Patrice, *Clinical Information Systems: A Component-Based Approach*, Springer, 2003
11. Steinberg, A.N., Bowman, C.L., White F.E., "Revisions to the JDL Data Fusion Model," in *Sensor Fusion: Architectures, Algorithms, and Applications*, Proceedings of the SPIE, Vol. 3719, 1999.
12. Llinas, J., Bowman, C., Rogova, G., Steinberg, A., Waltz, E., White F., "Revisiting the JDL Data Fusion Model II," *Proceedings of the 7th International Conference on Data Fusion*, Stockholm, Sweden, June-July 2004, pp. 1218-1230.
13. Steinberg, A.N., Bowman, C.L., "Rethinking the JDL Data Fusion Levels," presented at the National Symposium on Sensor and Data Fusion (NSSDF) at JHAPL, Laurel, Maryland, 2004.
14. Hall, D.L. and Llinas, J. (eds.), *Handbook of Multisensor Data Fusion*, CRC Press, 2001.
15. Hu, Hai, et. al, "Biomedical Informatics: Development of a Comprehensive Data Warehouse for Clinical and Genomic Breast Cancer Research," *Pharmacogenomics*, vol. 5, no. 7, p. 933-941, 2004
16. Ellsworth, Rachel, et. al, "The Clinical Breast Care Project: An Important Resource in Investigating Environmental and Genetic Contributions to Breast Cancer in African American Women," *Cell Tissue Banking*, 2007
17. Schwitzer, A Review of Features in Internet Consumer Health Decision-support Tools, *J Med Internet Res* 2002;4(2):e11
18. Kroening, M., et al, "Expanding WebLS to Support a Breast Cancer Decision Guide," *PC AI Magazine*, Volume 12, Number 2 Mar/Apr 98

CIS / HIT Internet References

Government

1. National Academies Institute of Medicine (www.iom.edu)
2. National Institutes of Health (www.nih.gov)
3. Office of National Coordinator (ONC) for Health Information Technology (www.hhs.gov/healthit/)
4. PubMed (www.pubmed.gov)

Non-Profit Organizations

1. American Health Information Management Association (AHIMA) (www.ahima.org)
2. American Medical Informatics Association (AMIA) (www.amia.org)
3. Association of pre-Operative Registered Nurses (AORN) (www.aorn.org)
4. California Health Care Foundation (CHCF) (www.chcf.org)
5. Clinical Data Interchange Standards Consortium (CDISC) (www.cdisc.org)
6. College of Healthcare Information Management Executives (CHIME) (www.cio-chime.org)
7. Healthcare Information and Management Systems Society (HIMSS) (www.himss.org/asp/index.asp)
8. iHealthRecord (www.ihealthrecord.org)
9. International Organization for Standardization's (ISO) Technical Committee (TC): ISA/TC 215 (www.iso.org) (www.isotc.iso.org)
10. The Joint Commission on the Accreditation of Health Care Organizations (JCAHO) (www.jointcommission.org)

11. openEHR (www.openEHR.org)
12. Pennsylvania eHealth Initiative (www.paehi.org)
13. Society for Clinical Data Management (SCDM) (www.scdm.org)

Industry

1. CareScience (www.carescience.com)
2. ClinicalData (www.clda.com)
3. dbMotion (www.dbmotion.com)
4. KLAS (www.healthcomputing.com)
5. Thomson Healthcare (Micromedex) (www.micromedex.com)

News and Information

1. Healthcare Technology: The Digital Healthcare System (www.hctproject.com)
2. HealthImaging.com (www.healthimaging.com)
3. iHealthBeat: Reporting Technology's Impact on Health Care (www.ihealthbeat.org)
4. Mayo Clinic (www.mayoclinic.com)
5. MedicineNet.com (www.medicinenet.com/script/main/hp.asp)
6. Modern Healthcare Online (www.modernhealthcare.com)
7. WebMD (www.webmd.com)

Breast Cancer Internet Resources

Government

1. Breast Cancer Action (www.bcaction.org)
2. Center for Disease Control Breast Cancer Site (www.cdc.gov/cancer/breast/)
3. Walter Reed Army Medical Center Clinical Breast Care Project (www.cbcp.info/)
4. Department of Defense Medical Research Breast Cancer Site (cdmrp.army.mil/bcrp/)
5. Lawrence Berkeley National Lab Breast Cancer Site (www.lbl.gov/Education/ELSI/screening-main.html)
6. National Breast Cancer Coalition (www.stopbreastcancer.org)
7. National Breast Cancer Foundation (www.nationalbreastcancer.org)
8. National Cancer Institute Breast Cancer Site (www.cancer.gov/cancertopics/types/breast)
9. National Genome Research Institute Breast Cancer Site (www.genome.gov/10000507)
10. National Library of Medicine, Genetics Home Reference Breast Cancer Site (ghr.nlm.nih.gov/condition=breastcancer)
11. National Library of Medicine, Medline Plus Breast Cancer Site (www.nlm.nih.gov/medlineplus/breastcancer.html)
12. U.S. Department of Health and Human Services Breast Cancer Site (www.womenshealth.gov/faq/cbreast.htm, www.hhs.gov/breastcancer/)
13. U.S. Department of Health and Human Services, Preventative Services Task Force Breast Cancer Screening Site (www.ahrq.gov/clinic/USpstf/uspsbrca.htm)
14. U.S. Food and Drug Administration Breast Cancer and Mammogram Site (www.fda.gov/opacom/lowlit/mammo.html)

Non-Profit Organizations

1. Alamo Breast Cancer Foundation (www.alamobreastcancer.org)

2. American Breast Cancer Foundation (www.abcf.org/)
3. American Cancer Society (www.cancer.org)
4. Babylon Breast Cancer Coalition (www.babylonbreastcancer.org/)
5. BreastCancer.org (www.breastcancer.org)
6. Breast Cancer Choices (www.breastcancerchoices.org/)
7. Breast Cancer Coalition of Rochester (www.bccr.org/)
8. Breast Cancer Prevention Institute (www.bcpinstitute.org/home.htm)
9. The Breast Cancer Research Foundation (www.bcrfcure.org)
10. California Breast Cancer Research program (www.cbcpr.org/)
11. Connecticut Breast Cancer Coalition and Foundation (www.cbccf.org/)
12. Georgia Breast Cancer Coalition Fund (www.gabcc.org/)
13. Huntington Breast Cancer Action Coalition (www.hbcac.org/)
14. Inflammatory Breast Cancer Association (www.ibchelp.org/)
15. Inflammatory Breast Cancer Research Foundation (www.ibcresearch.org/)
16. Linda Creed Breast Cancer Foundation (www.lindacreed.org/)
17. Massachusetts Breast Cancer Coalition (www.mbcc.org/)
18. Memorial Sloan-Kettering Cancer Center (www.mskcc.org/mskcc/html/293.cfm)
19. National Comprehensive Cancer Network (www.nccn.org/)
20. Susan G. Komen Breast Cancer Site (cms.komen.org/komen/index.htm)
21. Triple Negative Breast Cancer Foundation (www.tnbcfoundation.org/index.html)
22. Virginia Breast Cancer Foundation (www.vbcf.org/)
23. Windbur Research Institute (www.wriwindber.org/)
24. Zero Breast Cancer (www.breastcancerwatch.org/)

Academic Institutions

1. Duke University Advanced Imaging Laboratories (dailabs.duhs.duke.edu/about.html)
2. Johns Hopkins University AVON Foundation Breast Center (www.hopkinsbreastcenter.org/)
3. MD Anderson Breast Cancer Site (www.mdanderson.org/diseases/BreastCancer/)
4. Stanford Genomics Breast Cancer Consortium (genome-www.stanford.edu/breast_cancer/)
5. University of California Los Angeles Jonsson Comprehensive Cancer Center (www.cancer.ucla.edu/)
6. University of California San Francisco Breast Cancer Site (www.ucsfhealth.org/adult/medical_services/cancer/breast/)
7. University of Chicago Kurt Rossman Laboratories for Radiologic Image Research (www-radiology.uchicago.edu/krl/)
8. University of Michigan Department of Radiology (alpha3.rad.med.umich.edu/)

News and Information

1. About.com Breast Cancer Site (breastcancer.about.com)
2. Breast Cancer Advice (www.breastcanceradvice.com/)
3. Breast Cancer Awareness (www.breastcancerawareness.com/)
4. Breast Cancer Connections (www.bccconnections.org/wiki/Main_Page)
5. Breast Cancer Options (www.breastcanceroptions.org/MIDHUDSONOPTIONSPROJEC.asp)
6. Breast Cancer Research Online Journal (breast-cancer-research.com/)
7. The Breast Cancer Site (www.thebreastcancersite.com)
8. The Breast Cancer Source for Healthcare Professionals (www.breastcancersource.com/breastcancersourcehcp/)
9. Breast Cancer Update (www.breastcancerupdate.com/)

10. Breast Cancer Week (www.breastcancerweek.org/)
11. Cancer Resource Center of the Finger Lakes (www.ibca.net/)
12. CBS Breast Cancer Site (www.cbs.com/cbs_cares/breast_cancer/)
13. Doctor's Guide to Breast Cancer Information and Resources (www.pslgroup.com/BREASTCANCER.htm)
14. eMedicine Health Breast Cancer Site (www.emedicinehealth.com/breast_cancer/article_em.htm)
15. FamilyDoctor.org Cancer Site (familydoctor.org/online/famdocen/home/common/cancer.html)
16. Get Breast Cancer Facts (getbcfacts.com)
17. HealthCentral.com Breast Cancer Site (www.healthcentral.com/breast-cancer/)
18. HealthLine Breast Cancer Site (www.healthline.com/channel/breast-cancer.html)
19. Imaginis Breast Cancer Site (www.imaginis.com/breasthealth/breast_cancer.asp)
20. Lab Tests Online Breast Cancer Site (www.labtestsonline.org/understanding/conditions/breast.html)
21. Libertas Academica Cancer Articles Online (la-press.com/journal.php?journal_id=84)
22. Mayo Clinic Breast Cancer Site (www.mayoclinic.com/health/breast-cancer/DS00328)
23. Medical News Today Breast Cancer Site (www.medicalnewstoday.com/sections/breast_cancer/)
24. MedicineNet Breast Cancer Site (www.medicinenet.com/breast_cancer/article.htm)
25. Medscape Breast Cancer Site (www.medscape.com/resource/breastcancer)
26. Metastatic Breast Cancer Network (www.mbcnetwork.org/page.aspx?nm=mainpage)
27. NBC and iVillage YourTotalHealth Breast Cancer Site (yourhealthportal.com/breast-cancer)
28. New York Online Access to Health Breast Cancer Site (www.noah-health.org/en/cancer/types/breast/)
29. NY Times Breast Cancer Site (health.nytimes.com/health/guides/disease/breast-cancer/overview.html)
30. OncoLink Breast Cancer Site (www.oncolink.org/types/article.cfm?c=3&s=5&ss=33&id=8320)
31. Patient Health International Breast Cancer Site (www.patienthealthinternational.com/article/501572.aspx)
32. Public Health Institute Breast Cancer Answers (www.canceranswers.org/)
33. Radiation Therapy Answers Breast Cancer Site ([/www.rtanswers.org/treatment/disease/breast_cancer.htm](http://www.rtanswers.org/treatment/disease/breast_cancer.htm))
34. Radiology Info.com Breast Cancer Site (www.radiologyinfo.org/en/info.cfm?pg=breastcancer&bhcp=1)
35. RevolutionHealth Breast Cancer Site (www.revolutionhealth.com/conditions/breast-cancer/)
36. Science Daily.com Breast Cancer Site (www.sciencedaily.com/news/health_medicine/breast_cancer/)
37. Topix.com Breast Cancer Site (www.topix.com/health/breast-cancer)
38. WebMD Breast Cancer Site (www.webmd.com/breast-cancer/default.htm)
39. Women's Healthcare Forum Breast Cancer Site (www.womenshealthcareforum.com/breastcancer.cfm)

Decision Support Tools for Breast Cancer

1. Dartmouth-Hitchcock Medical Center Breast Cancer Toolkits
(www.dhmc.org/webpage.cfm?site_id=2&org_id=844&morg_id=0&sec_id=0&gsec_id=43605&item_id=43605)
2. Hologic R2 Image Checker (www.r2tech.com/main/home/index.php)
3. Online Breast Cancer Risk Calculator (www.halls.md/breast/risk.htm)